

GTL2014

4-bit LVTTTL to GTL transceiver

Rev. 3 — 14 June 2012

Product data sheet

1. General description

The GTL2014 is a 4-bit translating transceiver designed for 3.3 V LVTTTL system interface with a GTL-/GTL/GTL+ bus, where GTL-/GTL/GTL+ refers to the reference voltage of the GTL bus and the input/output voltage thresholds associated with it.

The direction pin allows the part to function as either a GTL to LVTTTL sampling receiver or as a LVTTTL to GTL interface.

The GTL2014 LVTTTL inputs (only) are tolerant up to 5.5 V allowing direct access to TTL or 5 V CMOS inputs. The LVTTTL outputs are not 5.5 V tolerant.

The GTL2014 GTL inputs and outputs operate up to 3.6 V, allowing the device to be used in higher voltage open-drain output applications.

GTL2014 is pin-to-pin backward compatible to the GTL2005 (labels for A port and B port are interchanged). GTL2014's V_{ref} tracks down to 0.5 V for low voltage CPU, propagation delays are slightly longer, while GTL2005's V_{ref} linearity degrades below 0.8 V and has shorter propagation delay.

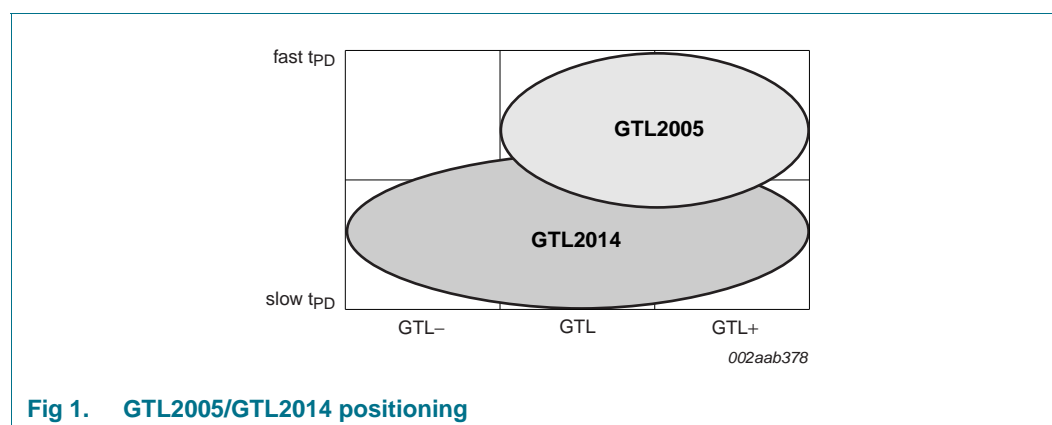


Fig 1. GTL2005/GTL2014 positioning

2. Features and benefits

- Operates as a 4-bit GTL-/GTL/GTL+ sampling receiver or as a LVTTTL to GTL-/GTL/GTL+ driver
- 3.0 V to 3.6 V operation with 5 V tolerant LVTTTL input
- GTL input and output 3.6 V tolerant
- V_{ref} adjustable from 0.5 V to $V_{CC}/2$
- Partial power-down permitted
- ESD protection exceeds 2000 V HBM per JESD22-A114 and 1000 V CDM per JESD22-CC101



- Latch-up protection exceeds 500 mA per JESD78
- Package offered: TSSOP14

3. Quick reference data

Table 1. Quick reference data

$T_{amb} = 25\text{ }^{\circ}\text{C}$

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------|-------------------------------|--|-----|-----|-----|------|
| t_{PLH} | LOW to HIGH propagation delay | An-to-Bn; $C_L = 50\text{ pF}$; $V_{CC} = 3.3\text{ V}$ | - | 2.8 | - | ns |
| t_{PHL} | HIGH to LOW propagation delay | An-to-Bn; $C_L = 50\text{ pF}$; $V_{CC} = 3.3\text{ V}$ | - | 3.4 | - | ns |
| t_{PLH} | LOW to HIGH propagation delay | Bn-to-An; $C_L = 50\text{ pF}$; $V_{CC} = 3.3\text{ V}$ | - | 5.2 | - | ns |
| t_{PHL} | HIGH to LOW propagation delay | Bn-to-An; $C_L = 50\text{ pF}$; $V_{CC} = 3.3\text{ V}$ | - | 4.9 | - | ns |
| C_i | input capacitance | control inputs; $V_I = 3.0\text{ V}$ or 0 V | - | 2 | 2.5 | pF |
| C_{io} | input/output capacitance | A port; $V_O = 3.0\text{ V}$ or 0 V | - | 4.6 | 6 | pF |
| | | B port; $V_O = V_{TT}$ or 0 V | - | 3.4 | 4.3 | pF |

4. Ordering information

Table 2. Ordering information

| Type number | Package | | |
|-------------|---------|--|----------|
| | Name | Description | Version |
| GTL2014PW | TSSOP14 | plastic thin shrink small outline package; 14 leads; body width 4.4 mm | SOT402-1 |

Standard packing quantities and other packaging data are available at
www.nxp.com/packages/.

4.1 Ordering options

Table 3. Ordering options

| Type number | Topside mark | Temperature range |
|-------------|--------------|--|
| GTL2014PW | GTL2014 | $T_{amb} = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ |

5. Functional diagram

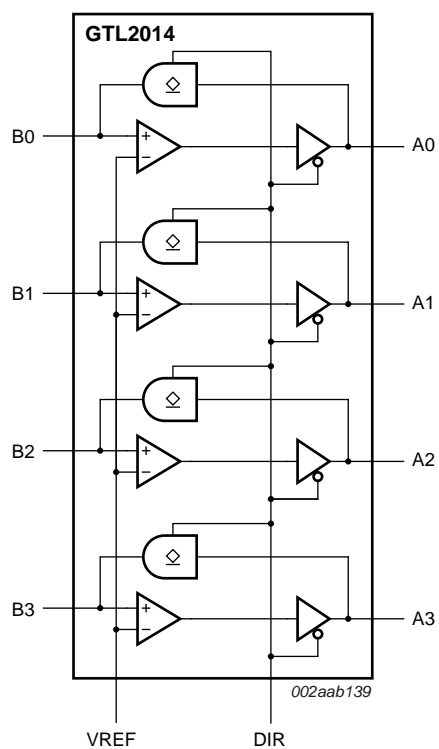
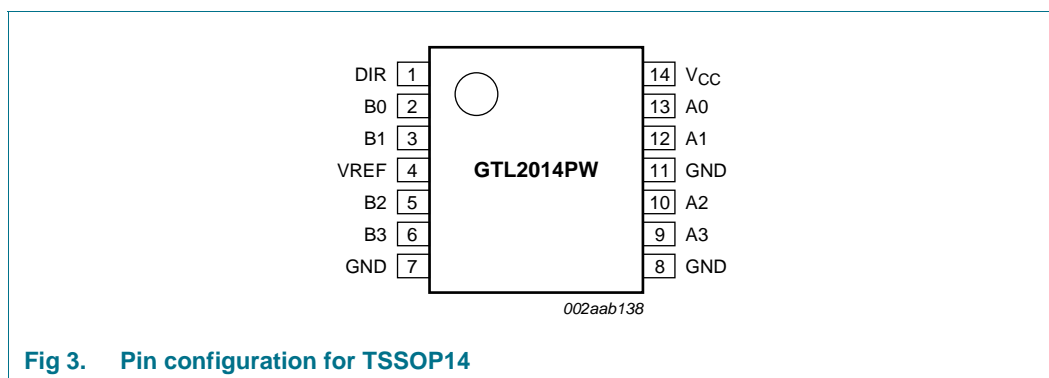


Fig 2. Logic diagram for GTL2014

6. Pinning information

6.1 Pinning



6.2 Pin description

Table 4. Pin description

| Symbol | Pin | Description |
|-----------------|----------|----------------------------------|
| DIR | 1 | direction control input (LVTTTL) |
| B0 | 2 | data inputs/outputs (GTL) |
| B1 | 3 | |
| B2 | 5 | |
| B3 | 6 | |
| A0 | 13 | data inputs/outputs (LVTTTL) |
| A1 | 12 | |
| A2 | 10 | |
| A3 | 9 | |
| VREF | 4 | GTL reference voltage |
| GND | 7, 8, 11 | ground (0 V) |
| V _{CC} | 14 | positive supply voltage |

7. Functional description

Refer to [Figure 2 “Logic diagram for GTL2014”](#).

7.1 Function table

Table 5. Function table

H = HIGH voltage level; L = LOW voltage level.

| Input | Input/output | |
|-------|--------------|---------|
| DIR | A (LVTTL) | B (GTL) |
| H | input | Bn = An |
| L | An = Bn | input |

8. Limiting values

Table 6. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).^[1]

Voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | Min | Max | Unit |
|------------------|---------------------------|--|---------------------|------|------|
| V _{CC} | supply voltage | | -0.5 | +4.6 | V |
| I _{IK} | input clamping current | V _I < 0 V | - | -50 | mA |
| V _I | input voltage | A port | -0.5 ^[2] | +7.0 | V |
| | | B port | -0.5 ^[2] | +4.6 | V |
| I _{OK} | output clamping current | A port; V _O < 0 V | - | -50 | mA |
| V _O | output voltage | output in OFF or HIGH state | | | |
| | | A port | -0.5 ^[2] | +7.0 | V |
| | | B port | -0.5 ^[2] | +4.6 | V |
| I _{OL} | LOW-level output current | current into any output in the LOW state | | | |
| | | A port | - | 32 | mA |
| | | B port | - | 80 | mA |
| I _{OH} | HIGH-level output current | current into any output in the HIGH state; A port | - | -32 | mA |
| T _{stg} | storage temperature | | ^[3] -60 | +150 | °C |

- [1] Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under [Section 9 “Recommended operating conditions”](#) is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- [2] The input and output negative voltage ratings may be exceeded if the input and output clamp current ratings are observed.
- [3] The performance capability of a high-performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability. The maximum junction temperature of this integrated circuit should not exceed 150 °C.

9. Recommended operating conditions

Table 7. Operating conditions [1]

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------|---------------------------|-----------------------|-------------------|---------------------|-------------------|------|
| V_{CC} | supply voltage | | 3.0 | - | 3.6 | V |
| V_{TT} | termination voltage[2] | GTL– | 0.85 | 0.9 | 0.95 | V |
| | | GTL | 1.14 | 1.2 | 1.26 | V |
| | | GTL+ | 1.35 | 1.5 | 1.65 | V |
| V_{ref} | reference voltage | overall | 0.5 | $\frac{2}{3}V_{TT}$ | $V_{CC}/2$ | V |
| | | GTL– | 0.5 | 0.6 | 0.63 | V |
| | | GTL | 0.76 | 0.8 | 0.84 | V |
| | | GTL+ | 0.87 | 1.0 | 1.10 | V |
| V_I | input voltage | B port | 0 | V_{TT} | 3.6 | V |
| | | except B port | 0 | 3.3 | 5.5[3] | V |
| V_{IH} | HIGH-level input voltage | B port | $V_{ref} + 0.050$ | - | - | V |
| | | except B port | 2 | - | - | V |
| V_{IL} | LOW-level input voltage | B port | - | - | $V_{ref} - 0.050$ | V |
| | | except B port | - | - | 0.8 | V |
| I_{OH} | HIGH-level output current | A port | - | - | -16 | mA |
| I_{OL} | LOW-level output current | B port | - | - | 40 | mA |
| | | A port | - | - | 16 | mA |
| T_{amb} | ambient temperature | operating in free-air | -40 | - | +85 | °C |

[1] Unused inputs must be held HIGH or LOW to prevent them from floating.

[2] V_{TT} maximum of 3.6 V with resistor sized so I_{OL} maximum is not exceeded.

[3] A0, A1, A2, A3 $V_{I(max)}$ is 3.6 V if configured as outputs (DIR = L).

10. Static characteristics

Table 8. Static characteristics

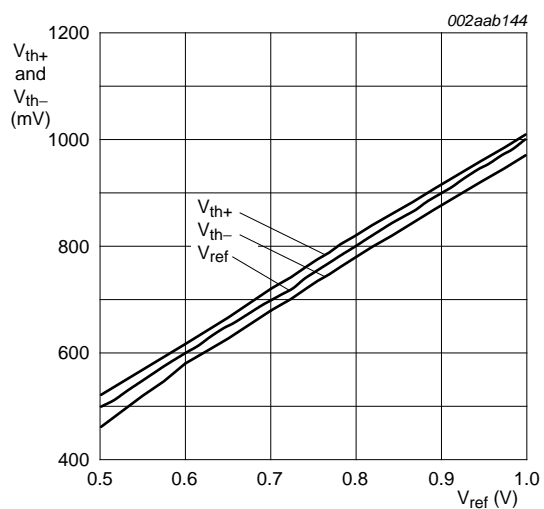
Recommended operating conditions; voltages are referenced to GND (ground = 0 V). $T_{amb} = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$

| Symbol | Parameter | Conditions | Min | Typ ^[1] | Max | Unit |
|--------------------------------|--|--|-------------------------------|--------------------|-----------|---------------|
| V_{OH} | HIGH-level output voltage | A port; $V_{CC} = 3.0\text{ V}$ to 3.6 V ; $I_{OH} = -100\text{ }\mu\text{A}$ | ^[2] $V_{CC} - 0.2$ | - | - | V |
| | | A port; $V_{CC} = 3.0\text{ V}$; $I_{OH} = -16\text{ mA}$ | ^[2] 2.0 | - | - | V |
| V_{OL} | LOW-level output voltage | B port; $V_{CC} = 3.0\text{ V}$; $I_{OL} = 40\text{ mA}$ | ^[2] - | 0.23 | 0.4 | V |
| | | A port; $V_{CC} = 3.0\text{ V}$; $I_{OL} = 8\text{ mA}$ | ^[2] - | 0.28 | 0.4 | V |
| | | A port; $V_{CC} = 3.0\text{ V}$; $I_{OL} = 12\text{ mA}$ | ^[2] - | 0.40 | 0.55 | V |
| | | A port; $V_{CC} = 3.0\text{ V}$; $I_{OL} = 16\text{ mA}$ | ^[2] - | 0.55 | 0.8 | V |
| | | A port; $V_{CC} = 3.0\text{ V}$; $I_{OL} = 16\text{ mA}$ | ^[2] - | 0.55 | 0.8 | V |
| I_I | input current | control inputs; $V_{CC} = 3.6\text{ V}$; $V_I = V_{CC}$ or GND | - | - | ± 1 | μA |
| | | B port; $V_{CC} = 3.6\text{ V}$; $V_I = V_{TT}$ or GND | - | - | ± 1 | μA |
| | | A port; $V_{CC} = 0\text{ V}$ or 3.6 V ; $V_I = 5.5\text{ V}$ | - | - | 10 | μA |
| | | A port; $V_{CC} = 3.6\text{ V}$; $V_I = V_{CC}$ | - | - | ± 1 | μA |
| | | A port; $V_{CC} = 3.6\text{ V}$; $V_I = 0\text{ V}$ | - | - | -5 | μA |
| I_{OZ} | OFF-state output current | A port; $V_{CC} = 0\text{ V}$; V_I or $V_O = 0\text{ V}$ to 3.6 V | - | - | ± 100 | μA |
| I_{CC} | quiescent supply current | A port; $V_{CC} = 3.6\text{ V}$; $V_I = V_{CC}$ or GND; $I_O = 0\text{ mA}$ | - | 4 | 10 | mA |
| | | B port; $V_{CC} = 3.6\text{ V}$; $V_I = V_{TT}$ or GND; $I_O = 0\text{ mA}$ | - | 4 | 10 | mA |
| ΔI_{CC} ^[3] | additional quiescent current (per input) | A port or control inputs; $V_{CC} = 3.6\text{ V}$; $V_I = V_{CC} - 0.6\text{ V}$ | - | - | 500 | μA |
| C_i | input capacitance | control inputs; $V_I = 3.0\text{ V}$ or 0 V | - | 2 | 2.5 | pF |
| C_{io} | input/output capacitance | A port; $V_O = 3.0\text{ V}$ or 0 V | - | 4.6 | 6 | pF |
| | | B port; $V_O = V_{TT}$ or 0 V | - | 3.4 | 4.3 | pF |

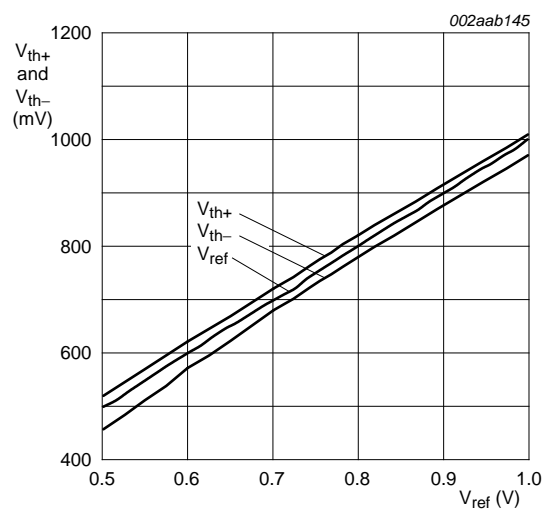
[1] All typical values are measured at $V_{CC} = 3.3\text{ V}$ and $T_{amb} = 25\text{ }^{\circ}\text{C}$.

[2] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

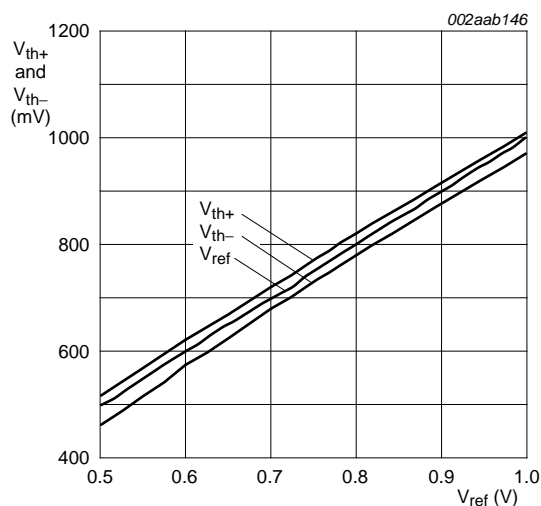
[3] This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.



a. $V_{CC} = 3.0 \text{ V}$; $T_{amb} = -40 \text{ }^{\circ}\text{C}$



b. $V_{CC} = 3.3 \text{ V}$; $T_{amb} = 25 \text{ }^{\circ}\text{C}$



c. $V_{CC} = 3.6 \text{ V}$; $T_{amb} = 85 \text{ }^{\circ}\text{C}$

V_{ref} is equal to the reference voltage on the GTL bus.

V_{th+} is the GTL input high threshold, which is typically equal to $V_{ref} + 50 \text{ mV}$.

V_{th-} is the GTL input low threshold, which is typically equal to $V_{ref} - 50 \text{ mV}$.

Fig 4. GTL V_{th+} and V_{th-} versus V_{ref}

11. Dynamic characteristics

Table 9. Dynamic characteristics

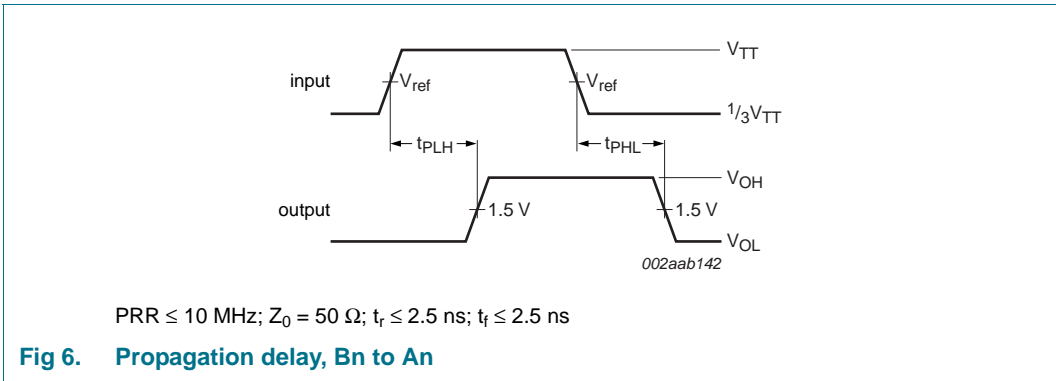
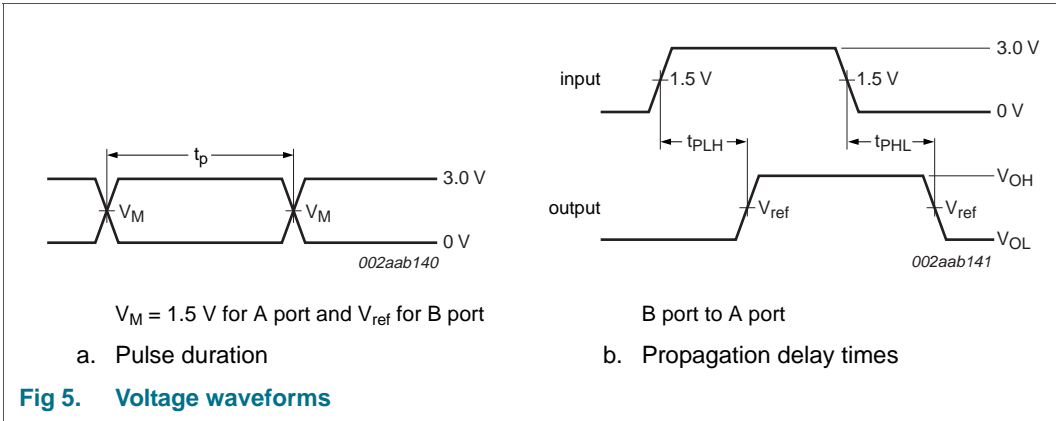
$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$

| Symbol | Parameter | Conditions | Min | Typ ^[1] | Max | Unit |
|--|-------------------------------|--|-----|--------------------|-----|------|
| GTL-; $V_{ref} = 0.6\text{ V}$; $V_{TT} = 0.9\text{ V}$ | | | | | | |
| t_{PLH} | LOW to HIGH propagation delay | An to Bn; see Figure 5 | - | 2.8 | 5 | ns |
| t_{PHL} | HIGH to LOW propagation delay | An to Bn; see Figure 5 | - | 3.3 | 7 | ns |
| t_{PLH} | LOW to HIGH propagation delay | Bn to An; see Figure 6 | - | 5.3 | 8 | ns |
| t_{PHL} | HIGH to LOW propagation delay | Bn to An; see Figure 6 | - | 5.2 | 8 | ns |
| GTL; $V_{ref} = 0.8\text{ V}$; $V_{TT} = 1.2\text{ V}$ | | | | | | |
| t_{PLH} | LOW to HIGH propagation delay | An to Bn; see Figure 5 | - | 2.8 | 5 | ns |
| t_{PHL} | HIGH to LOW propagation delay | An to Bn; see Figure 5 | - | 3.4 | 7 | ns |
| t_{PLH} | LOW to HIGH propagation delay | Bn to An; see Figure 6 | - | 5.2 | 8 | ns |
| t_{PHL} | HIGH to LOW propagation delay | Bn to An; see Figure 6 | - | 4.9 | 7 | ns |
| GTL+; $V_{ref} = 1.0\text{ V}$; $V_{TT} = 1.5\text{ V}$ | | | | | | |
| t_{PLH} | LOW to HIGH propagation delay | An to Bn; see Figure 5 | - | 2.8 | 5 | ns |
| t_{PHL} | HIGH to LOW propagation delay | An to Bn; see Figure 5 | - | 3.4 | 7 | ns |
| t_{PLH} | LOW to HIGH propagation delay | Bn to An; see Figure 6 | - | 5.1 | 8 | ns |
| t_{PHL} | HIGH to LOW propagation delay | Bn to An; see Figure 6 | - | 4.7 | 7 | ns |

[1] All typical values are at $V_{CC} = 3.3\text{ V}$ and $T_{amb} = 25\text{ }^{\circ}\text{C}$.

11.1 Waveforms

$V_M = 1.5\text{ V}$ at $V_{CC} \geq 3.0\text{ V}$; $V_M = V_{CC}/2$ at $V_{CC} \leq 2.7\text{ V}$ for A ports and control pins;
 $V_M = V_{ref}$ for B ports.



12. Test information

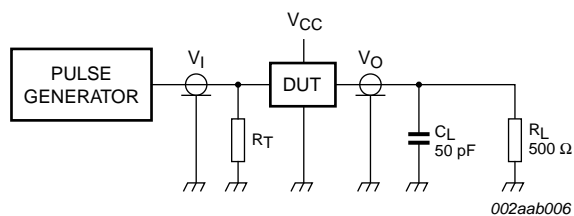


Fig 7. Load circuitry for switching times

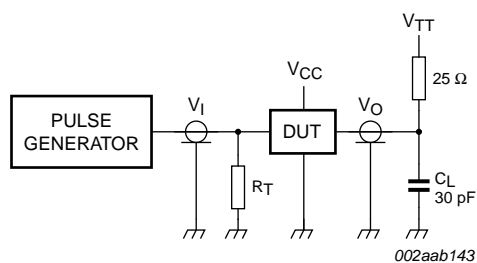


Fig 8. Load circuit for B outputs

R_L — Load resistor

C_L — Load capacitance; includes jig and probe capacitance

R_T — Termination resistance; should be equal to output impedance of pulse generators.

13. Package outline

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm SOT402-1

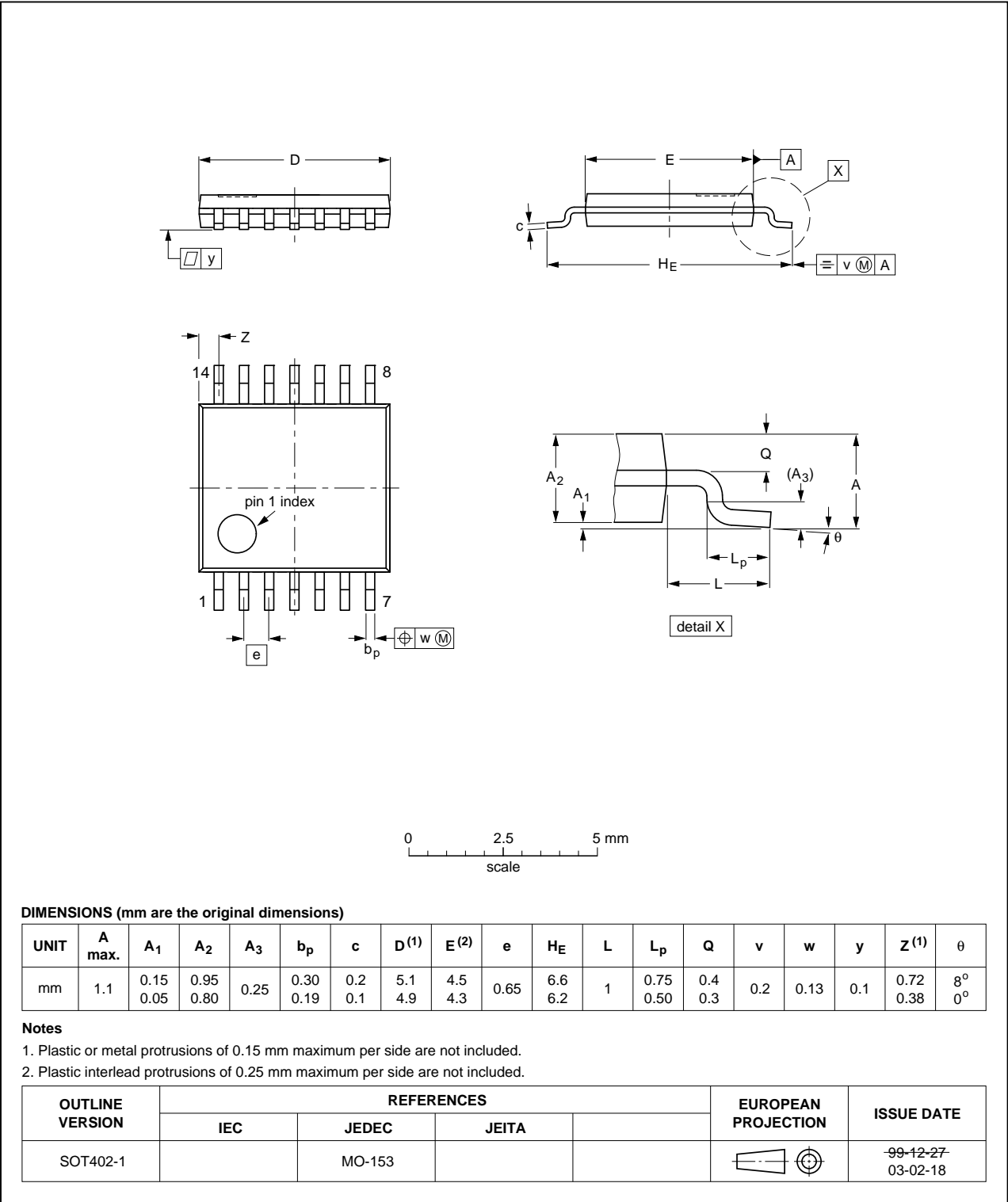


Fig 9. Package outline SOT402-1 (TSSOP14)

14. Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

14.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

14.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leadless or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leadless SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leadless packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

14.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

14.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see [Figure 10](#)) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with [Table 10](#) and [11](#)

Table 10. SnPb eutectic process (from J-STD-020C)

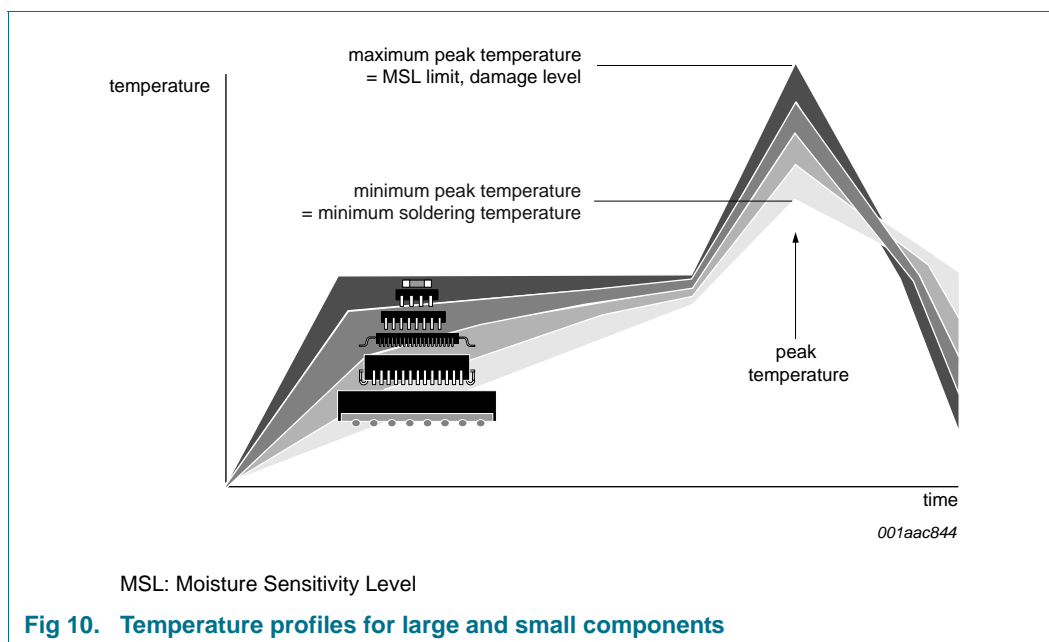
| Package thickness (mm) | Package reflow temperature (°C) | |
|------------------------|---------------------------------|-------|
| | Volume (mm ³) | |
| | < 350 | ≥ 350 |
| < 2.5 | 235 | 220 |
| ≥ 2.5 | 220 | 220 |

Table 11. Lead-free process (from J-STD-020C)

| Package thickness (mm) | Package reflow temperature (°C) | | |
|------------------------|---------------------------------|-------------|--------|
| | Volume (mm ³) | | |
| | < 350 | 350 to 2000 | > 2000 |
| < 1.6 | 260 | 260 | 260 |
| 1.6 to 2.5 | 260 | 250 | 245 |
| > 2.5 | 250 | 245 | 245 |

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see [Figure 10](#).



For further information on temperature profiles, refer to Application Note *AN10365* “Surface mount reflow soldering description”.

15. Abbreviations

Table 12. Abbreviations

| Acronym | Description |
|---------|---|
| CDM | Charged-Device Model |
| CMOS | Complementary Metal-Oxide Semiconductor |
| CPU | Central Processing Unit |
| ESD | ElectroStatic Discharge |
| GTL | Gunning Transceiver Logic |
| HBM | Human Body Model |
| LVTTTL | Low Voltage Transistor-Transistor Logic |
| PRR | Pulse Rate Repetition |
| TTL | Transistor-Transistor Logic |

16. Revision history

Table 13. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---------------------------------|---|--------------------|---------------|-------------|
| GTL2014 v.3 | 20120614 | Product data sheet | - | GTL2014 v.2 |
| Modifications: | <ul style="list-style-type: none">• Section 1 “General description”, first paragraph, first sentence: added phrase “where GTL-/GTL/GTL+ refers to the reference voltage of the GTL bus and the input/output voltage thresholds associated with it”• Added (new) Figure 4 “GTL V_{th+} and V_{th-} versus V_{ref}” | | | |
| GTL2014 v.2 | 20120306 | Product data sheet | - | GTL2014 v.1 |
| GTL2014 v.1 (9397 750 13534) | 20050519 | Product data sheet | - | - |

17. Legal information

17.1 Data sheet status

| Document status ^{[1][2]} | Product status ^[3] | Definition |
|-----------------------------------|-------------------------------|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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